Grand Valley State University
www.gvsu.edu

Cloud Computing Introduction / Motivation

CIS437
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Adapted from Google Cloud Computing Foundations, Overview of Cloud Computing (Wufka & Canonico)

Overview

- Welcome!
- Syllabus
- Cloud things

But first, let's play a "read and repeat" game!

I WILL NOT

USE MY CREDIT CARD

ON ANY CLOUD SERVICE

But first, let's play a "read and repeat" game!

EVEN IF THEY ASK NICELY

SO I CAN START A FREE TRIAL

HOME

What we ***will*** cover

Wide variety of cloud technologies

- Mostly focused on Google Cloud, but we'll take a look at AWS
  - Azure doesn't give out free education credits and I don't want you to burn your free trials
  - Fortunately, all skills are transferable between cloud environments

- All different points of the cloud stack

What do you want to cover?

Knowledge you are **assumed to have**

Ability to program in **some language**

- You will be working on a real project!

Ability to work **individually** and on **teams**

- You're an adult, I also expect maturity and even effort-sharing where necessary

Ability to **talk to me if you have problems**

- Don't be nervous, I am very approachable!

How class will *generally* work

Our classes are 2 - 1 hr 15min sessions per week

- Classes will be a mix of:
  - Lecture
  - Discussions
  - Labwork
    - Guided/self-guided work

Subject to change based on material, naturally

- But, I want you to get **practical experience**

PROJECTS

You will develop a half-semester-long project

Goals of this project:

1) Have something portfolio-worthy at the end

2) Develop it like a real-world project
    a) Proposal, updates, presentation, etc.

3) More detail around midterm - start thinking of something *now* you'd like to "cloudify"

Project?

I want you to create something that is **interesting to you**

Are you a software developer with latent tendencies for video game design?

- Make a *cloud-hosted* video game!

Aspiring app developer?

- Make that app (...using cloud technologies)!

Sysadmin?

- Manage a load-balanced server application of some sort!

No clue!?!?

- Let's talk

It will need to contain a handful of cloud services though, not just one!

Research!

Also, I do research! Sometimes in the cloud!

- Research being exploring something new or interesting and writing academic papers on it

If you are interested, please reach out to me via email/Discord and we can chat

- It would involve a longer term project with the possibility of a publication on your resume/CV

- And probably extra credit since it would be more involved

Our tech stack

Class is **synchronous in-person**, meaning:

1) Class runs at specific days/times
2) Office hours are in-person (can be online) as well

Class website: Blackboard // https://efredericks.github.io/gvsu-cis437/
Async Chat: Discord

If you want to get a hold of me for questions:

- Ping me in Discord
- Email me
- Visit office hours (virtual or in-person (generally))

Syllabus

As always, the syllabus is **worth reading**

Important topics like:

- When is my final exam?
- What is the grading breakdown?
- What time does this class meet?
- Where can I find the nifty textbook?

Questions so far?

burgertv:

> Tina asking the important questions

Source: burgertv

So...

What cloud technologies are you familiar with?

And so...

What do **you** think of when you hear cloud computing?

Google Euro Data Center

Google Iowa Data Center

FULL DISCLOSURE

99% of my demos will most likely be with Google Cloud

- They have a *really good* education program
  - (Very easy to get credits for teaching others)

AWS is … OK

Azure is … non-existent for education

—

But, all skills are 100% transferable (concepts same, syntax different)

[VMs] Google Cloud Compute Engine (VMs) == AWS Compute

[Serverless] Google Cloud Cloud Functions == AWS Lambda Functions

…etc.

CLOUD SERVICES

	aws		
Virtual Servers	Instances	VM Instances	VMs
Platform-as-a-Service	Elastic Beanstalk	App Engine	Cloud Services
Serverless Computing	Lambda	Cloud Functions	Azure Functions
Docker Management	ECS	Container Engine	Container Service
Kubernetes Management	EKS	Kubernetes Engine	Kubernetes Service
Object Storage	S3	Cloud Storage	Block Blob
Archive Storage	Glacier	Coldline	Archive Storage
File Storage	EFS	ZFS / Avere	Azure Files
Global Content Delivery	CloudFront	Cloud CDN	Delivery Network
Managed Data Warehouse	Redshift	Big Query	SQL Warehouse

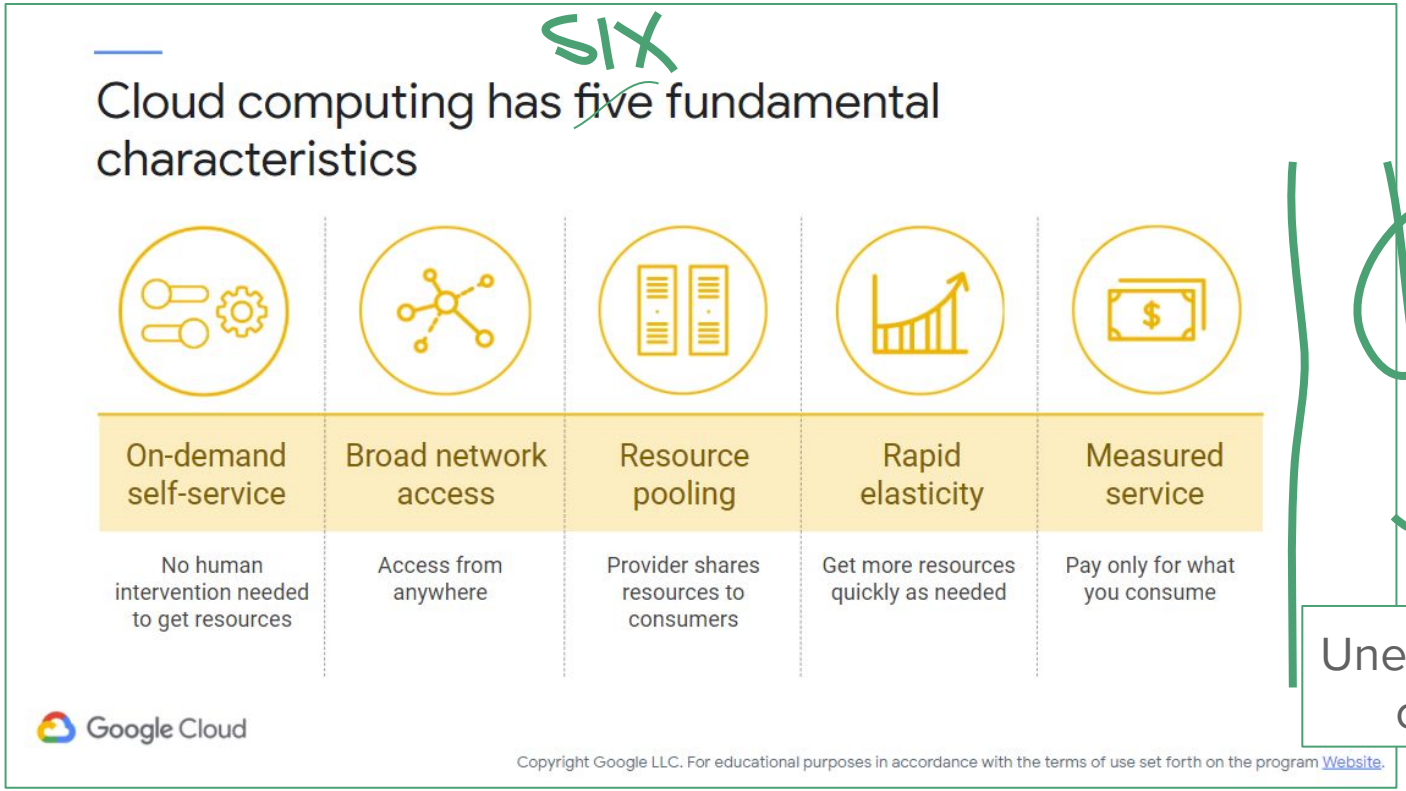
So what *is* cloud computing

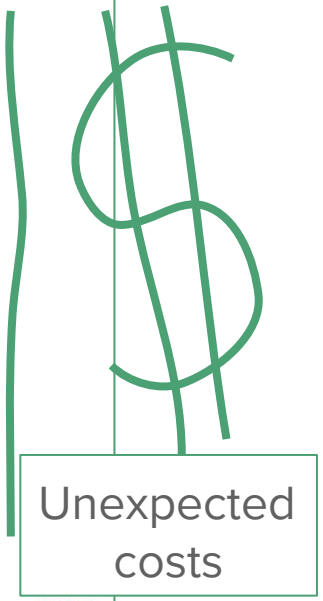
Cloud computing has five fundamental characteristics

On-demand self-service	Broad network access	Resource pooling	Rapid elasticity	Measured service
No human intervention needed to get resources	Access from anywhere	Provider shares resources to consumers	Get more resources quickly as needed	Pay only for what you consume

Google Cloud

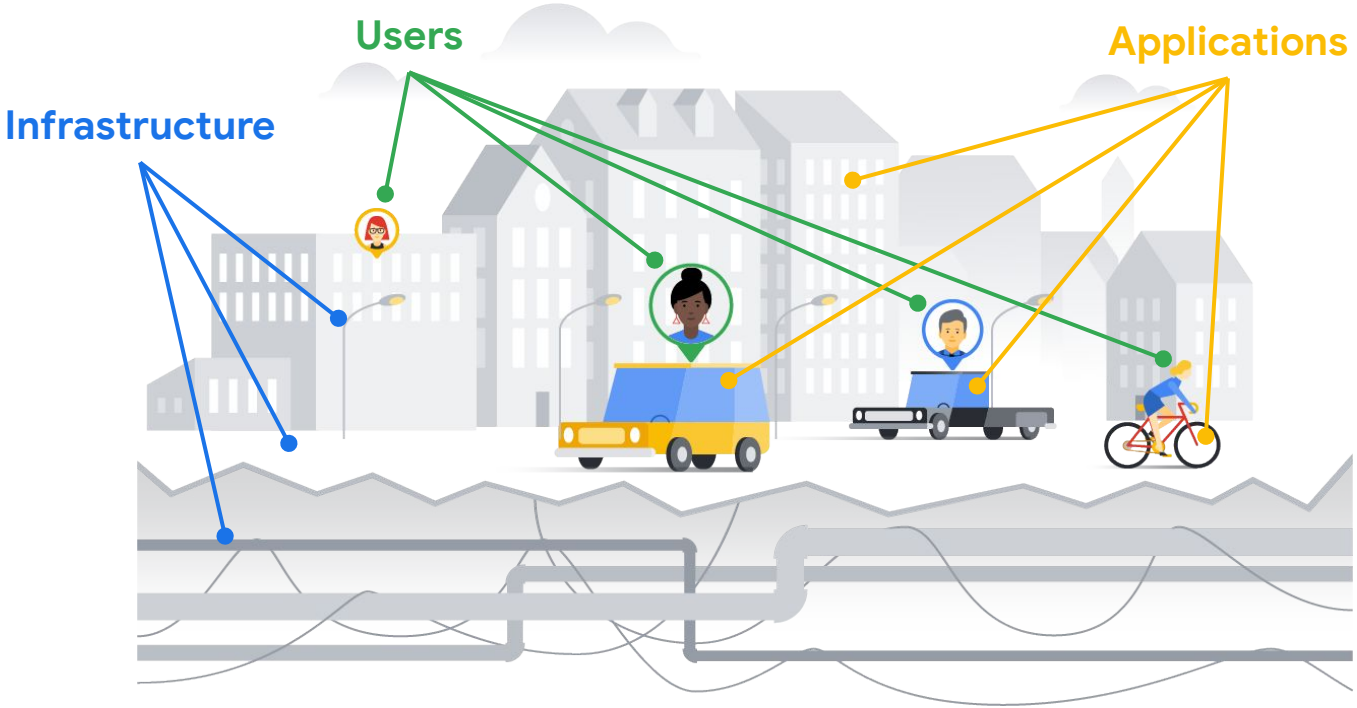
and...





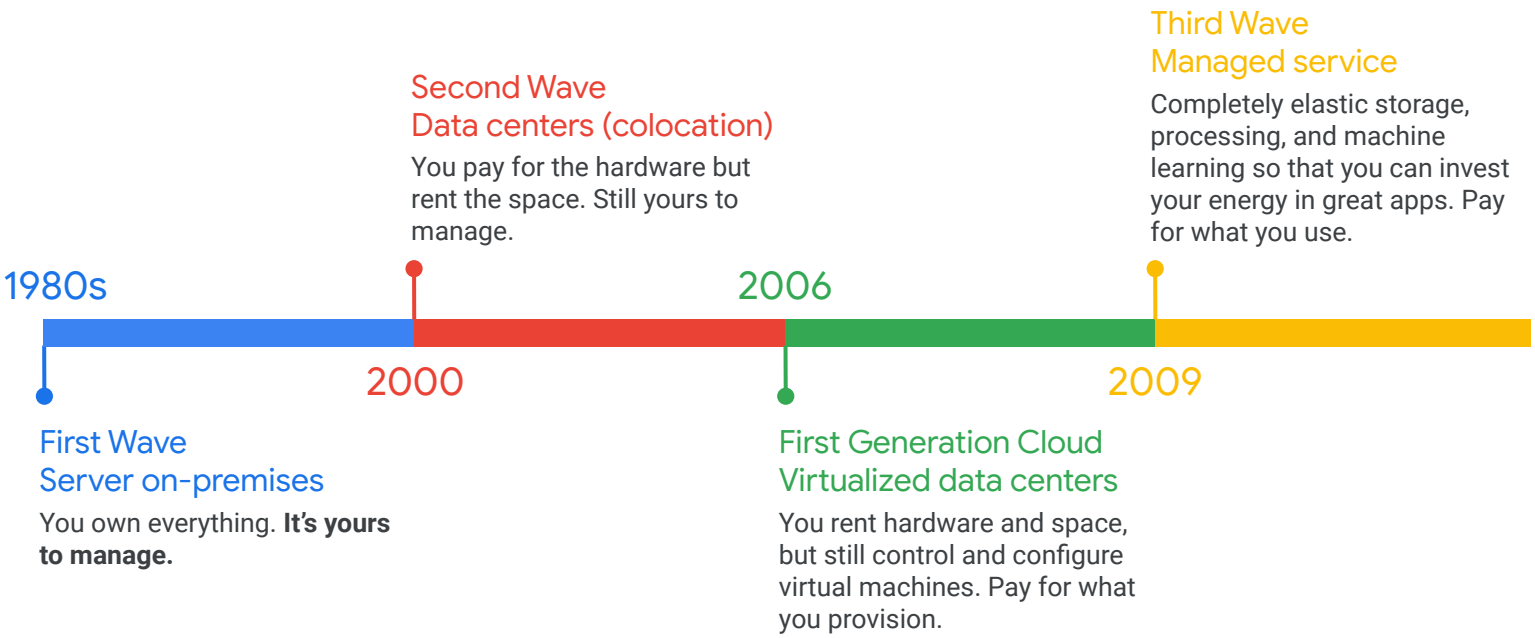
Unexpected costs

An IT infrastructure is like a "city infrastructure"



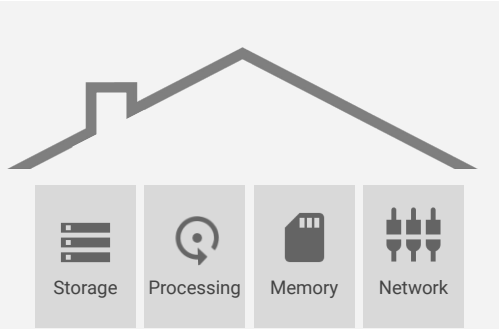
Google Cloud

Cloud computing is a continuation of a long-term shift in how computing resources are managed



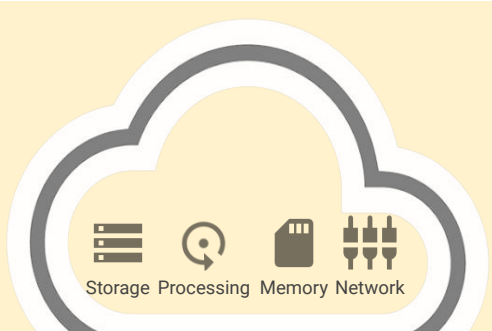
Google Cloud

The cloud has seen a similar progression



Physical/Colocation

User-configured, managed, and maintained



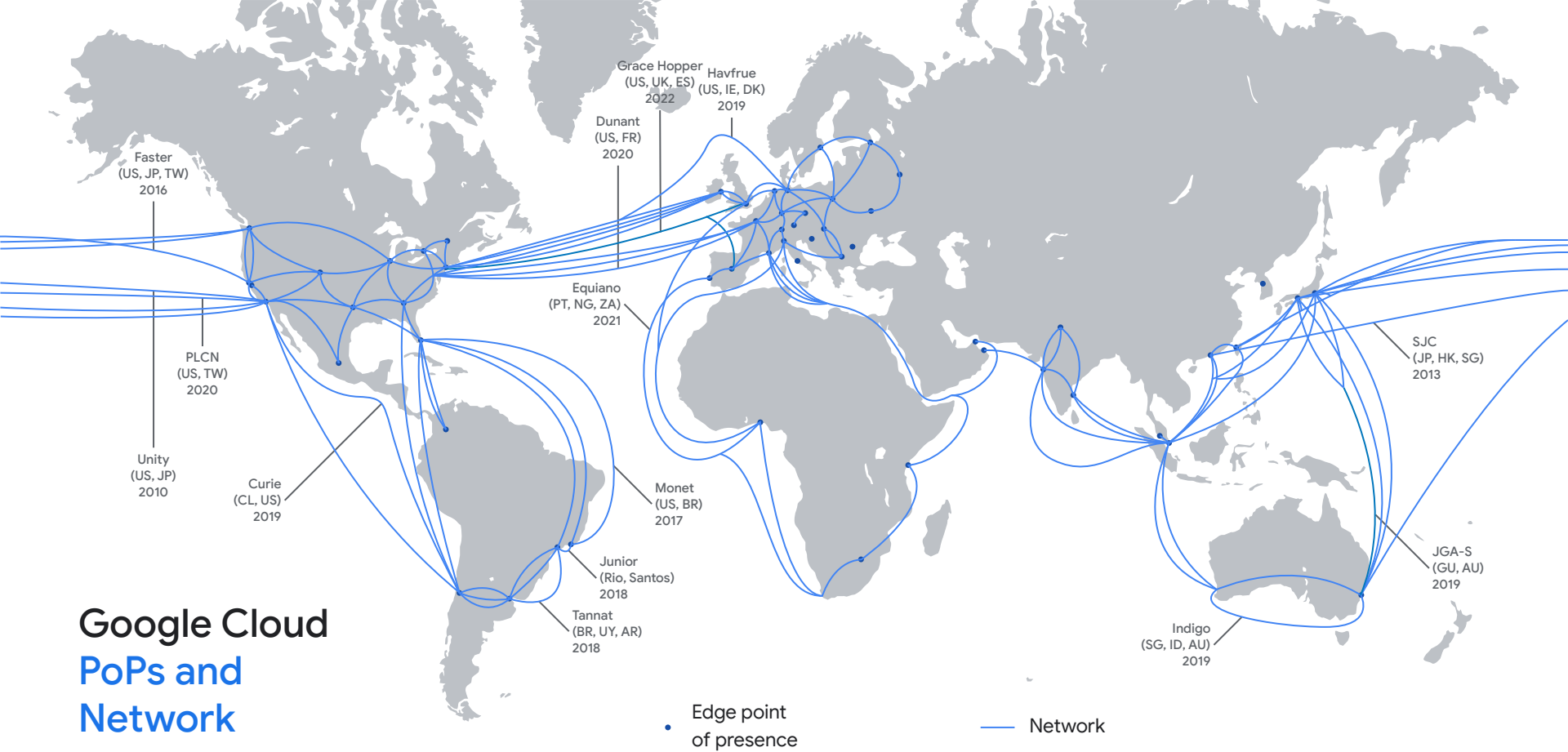
Virtualized

User-configured
Provider managed, and maintained

Serverless

Fully automated

Google Cloud



Google Cloud PoPs and Network

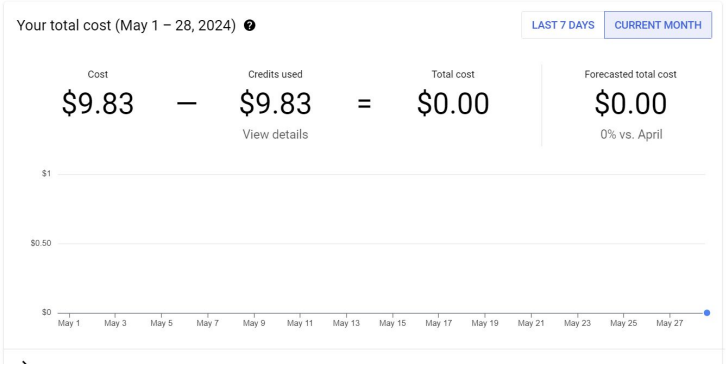
Edge point of presence

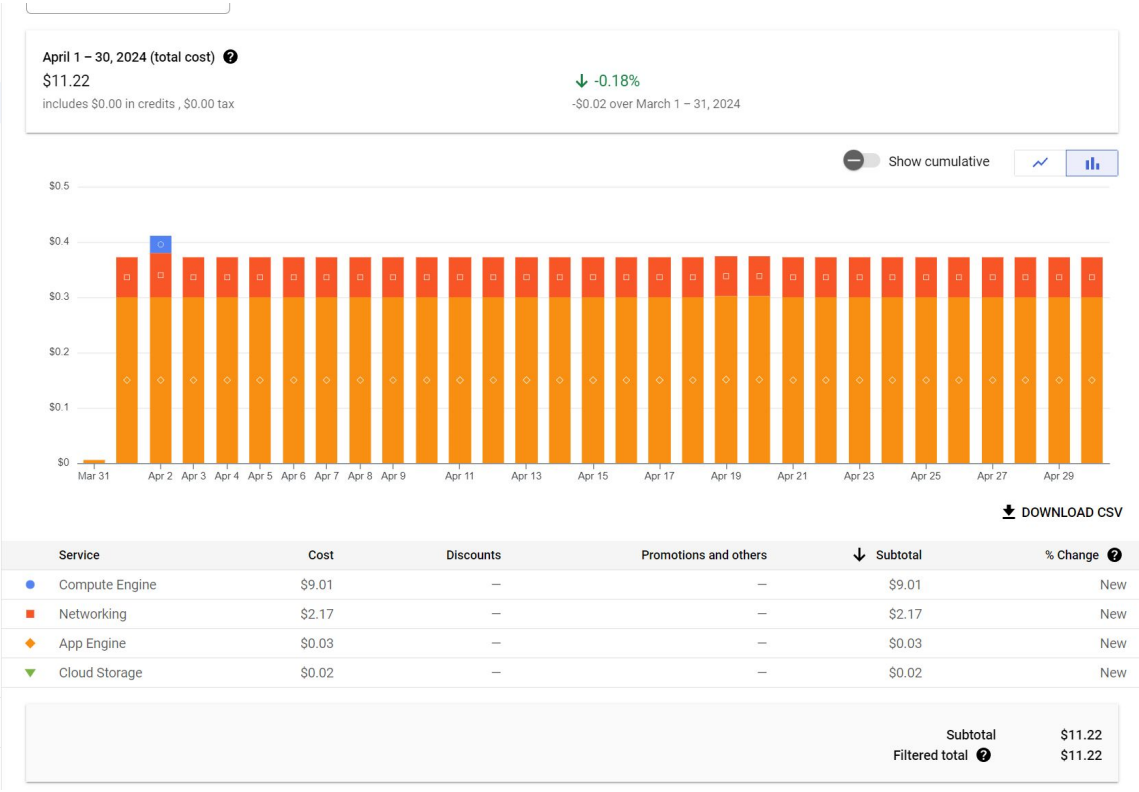
Network

Google Cloud


But first...

ALWAYS CHECK YOUR BILLING STATEMENT





I didn't even realize I had charges...

$$ for this class

Everything in this class is **free to you**

- Do **not** put your credit card into ANY service
  - That is a great way to find auto-charges in a year when you forgot to shut things off

- If you run out of credits **ask me for more**
  - I get them for free through Google

If it is on, it is costing you money

Any time *anything* is active in the cloud, you are being charged for it

- Virtual machine exists but off?
  - Charge for the hard drive storage
- Serverless function active?
  - Charge for the build/deploy activities
  - Charge for any invocations
- Look at the cloud funny?
  - Probably a charge for that too

Intention is to *scare* you into paying attention

Unless if otherwise specified, **turn things off when you're done**

You do not want to be out of credits the night a homework assignment is due

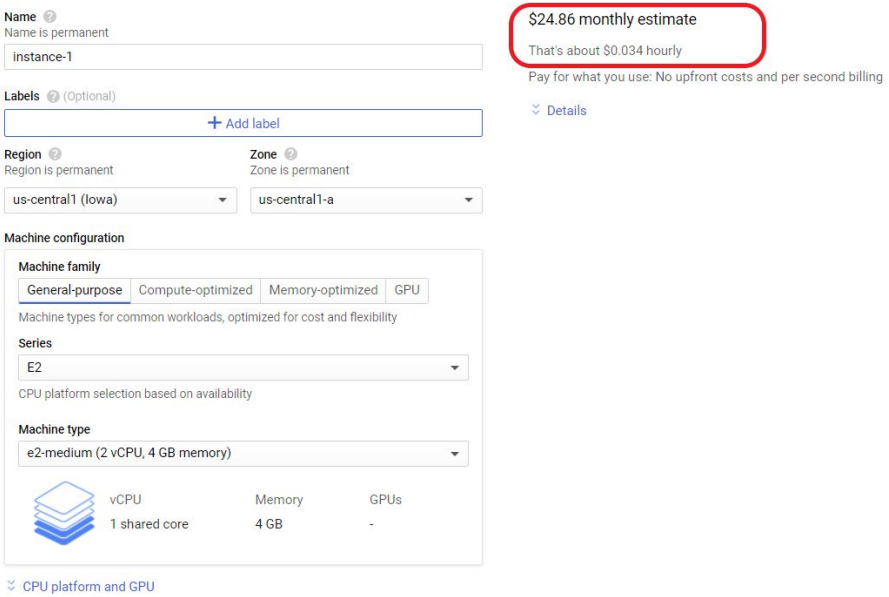
- Note: I typically don't respond to emails the evenings that assignments are due, **start early**

I can get you more credits if you let me know **ahead of time**

- Sometimes a credits request can take more time than expected

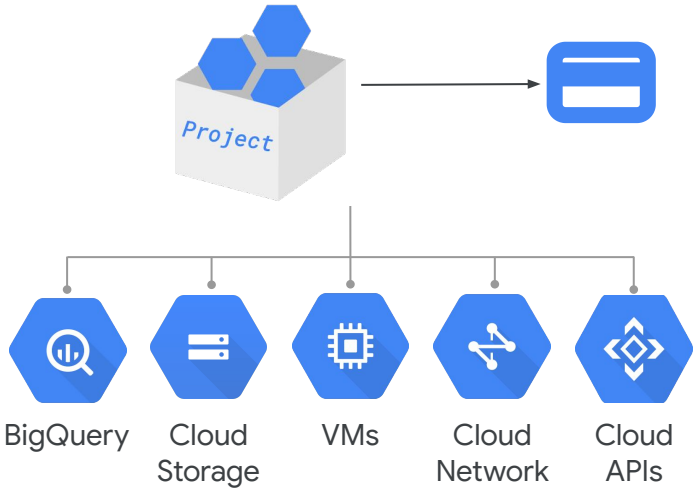
Cost reduction suggestions

1. Shut down all virtual machines when not in use
2. Set up access rights for all services
3. Do not publish any keys, API information, passwords, etc. to any form of version control
4. Set quotas for all users



How billing works

- Billing account pays for project resources.
- A billing account is linked to zero or more projects.
- Accounts are charged automatically, invoiced monthly, or invoiced at the threshold limit.
- Sub accounts can be used for separate billing for projects.



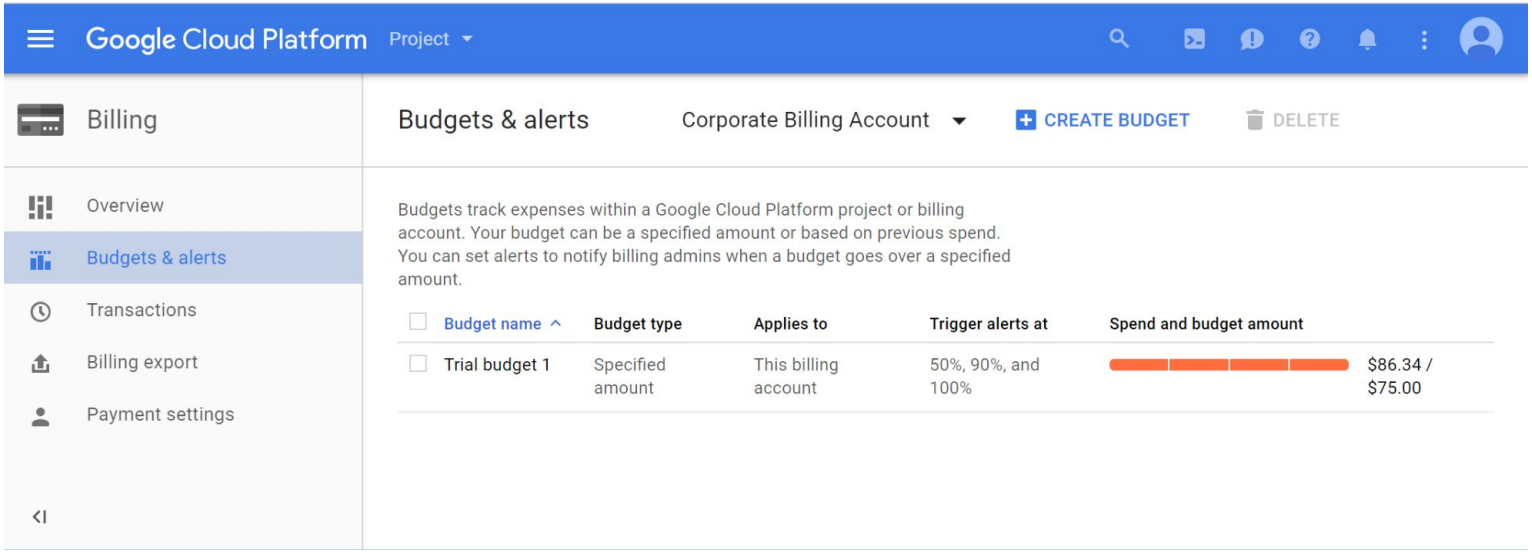
Google Cloud

How to keep your billing under control

1. Budgets and alerts
2. Billing export
3. Reports
4. Quotas

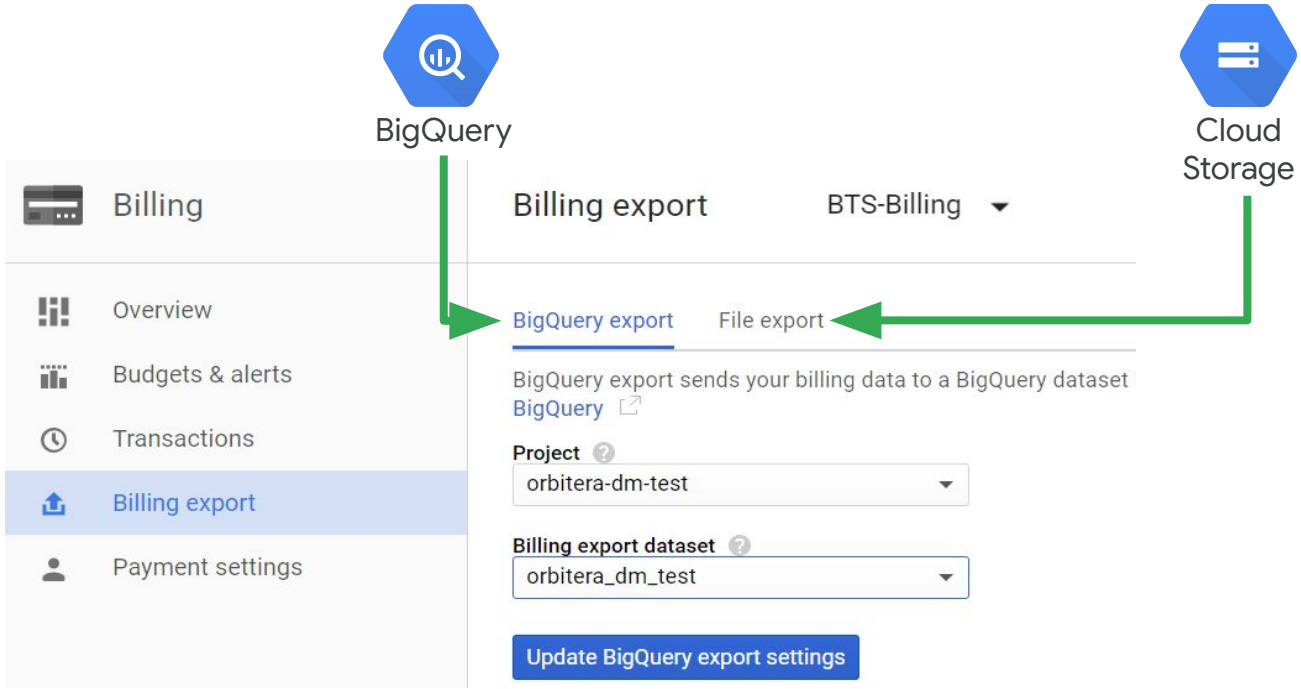
Google Cloud

Budgets and alerts keep your billing under control



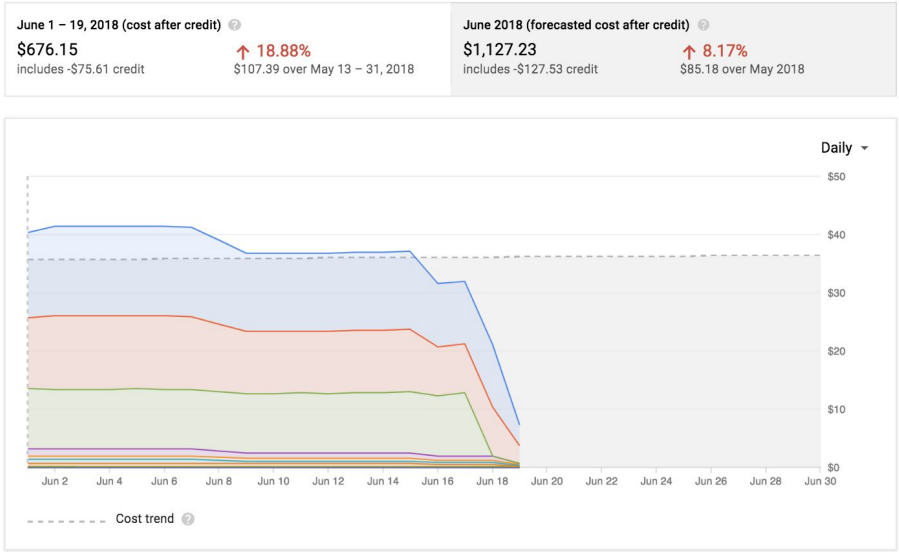
Google Cloud

Billing export allows you to store detailed billing information



Google Cloud

Reports is a visual tool to monitor expenditure



PROJECT	PROJECT ID	COST BEFORE CREDIT	CREDIT	COST AFTER CREDIT
My Project 194	my-project-194-1378	$287.07	-$36.11	$250.96
My Project 301	my-project-301-1492	$233.12	-$31.00	$202.12
My Project 315	my-project-315-9812	$175.00	$0.00	$175.00

Google Cloud

Quotas are helpful limits

Rate quota

GKE API: 1,000 requests per 100 seconds

Allocation quota

5 networks per project

Many quotas are changeable

Google Cloud

Cloud service models (more on this later)

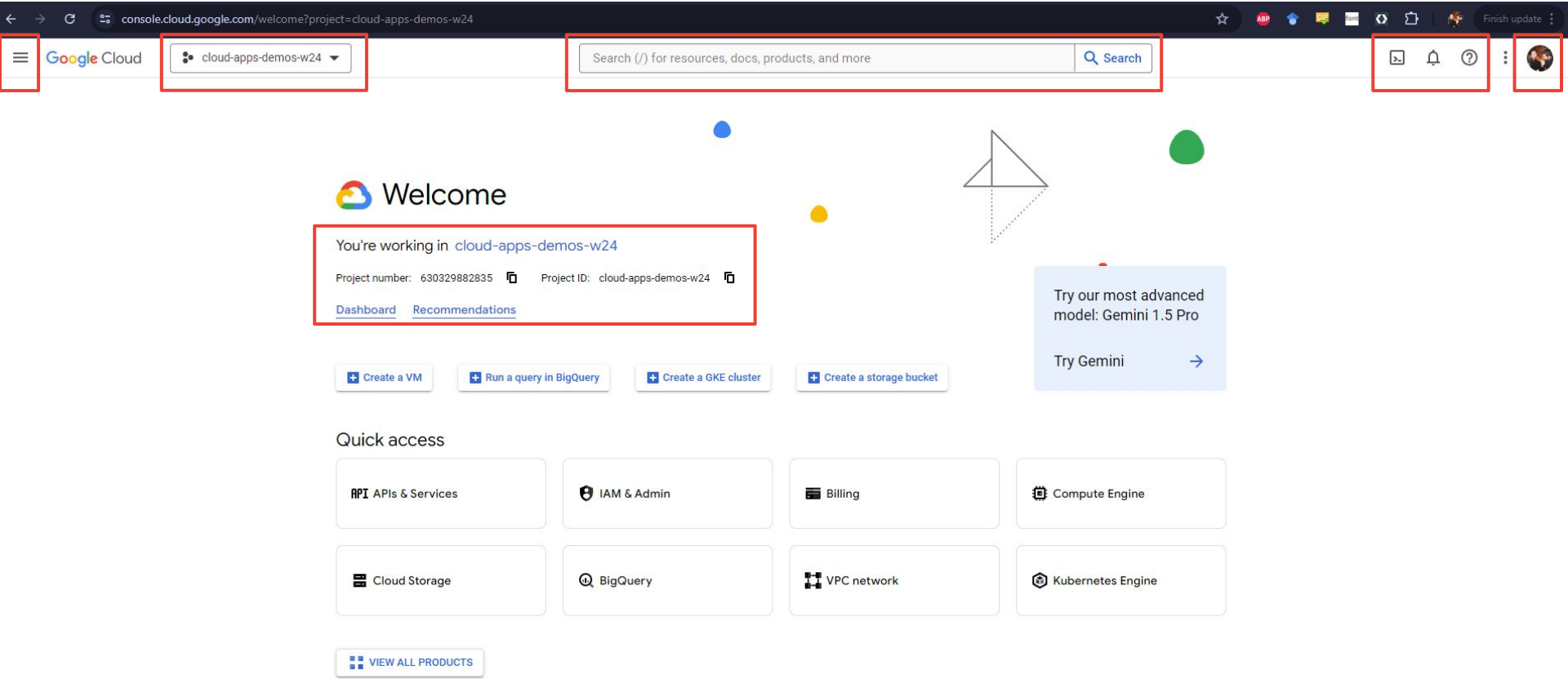
Infrastructure as a service (IaaS)
- Physical devices virtualized (e.g., virtual machines)

Platform as a service (PaaS)
- Environments virtualized (e.g., LAMP stack)

Software as a service (SaaS)
- Applications virtualized (e.g., Office365)

The interface (Google Cloud)

Google Cloud Interface (console.cloud.google.com)

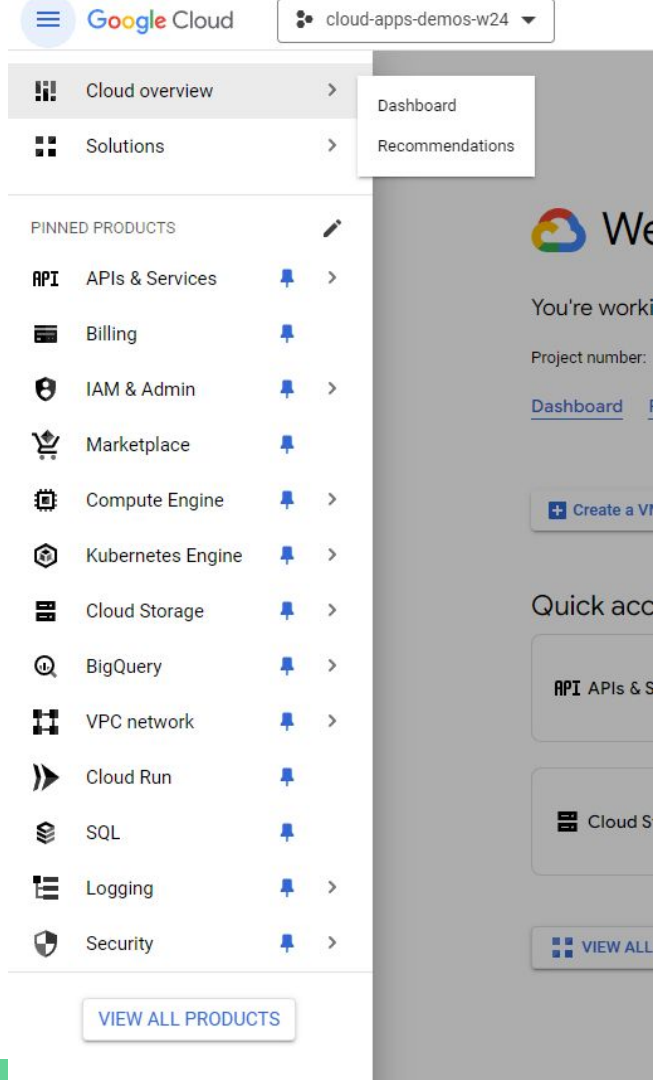


With Google Cloud credits:

- **All** products are available to you!
- (and I can get you more *when* you run out)
  - NEVER PUT IN YOUR CREDIT CARD (AGAIN)

AWS - you're limited to the pre-baked labs

Azure - ...

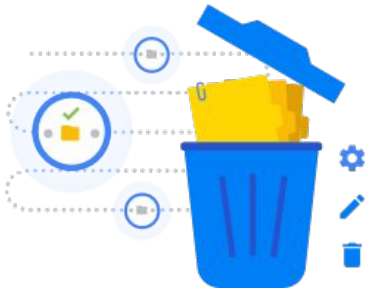


First...

Let's talk about Projects in Google Cloud

Every Google Cloud service you use is associated with a project

- Enable services and APIs.
- Enable billing.
- Manage permissions and credentials.
- Track resource and quota usage.
- Programmatically manage your projects in Google Cloud.

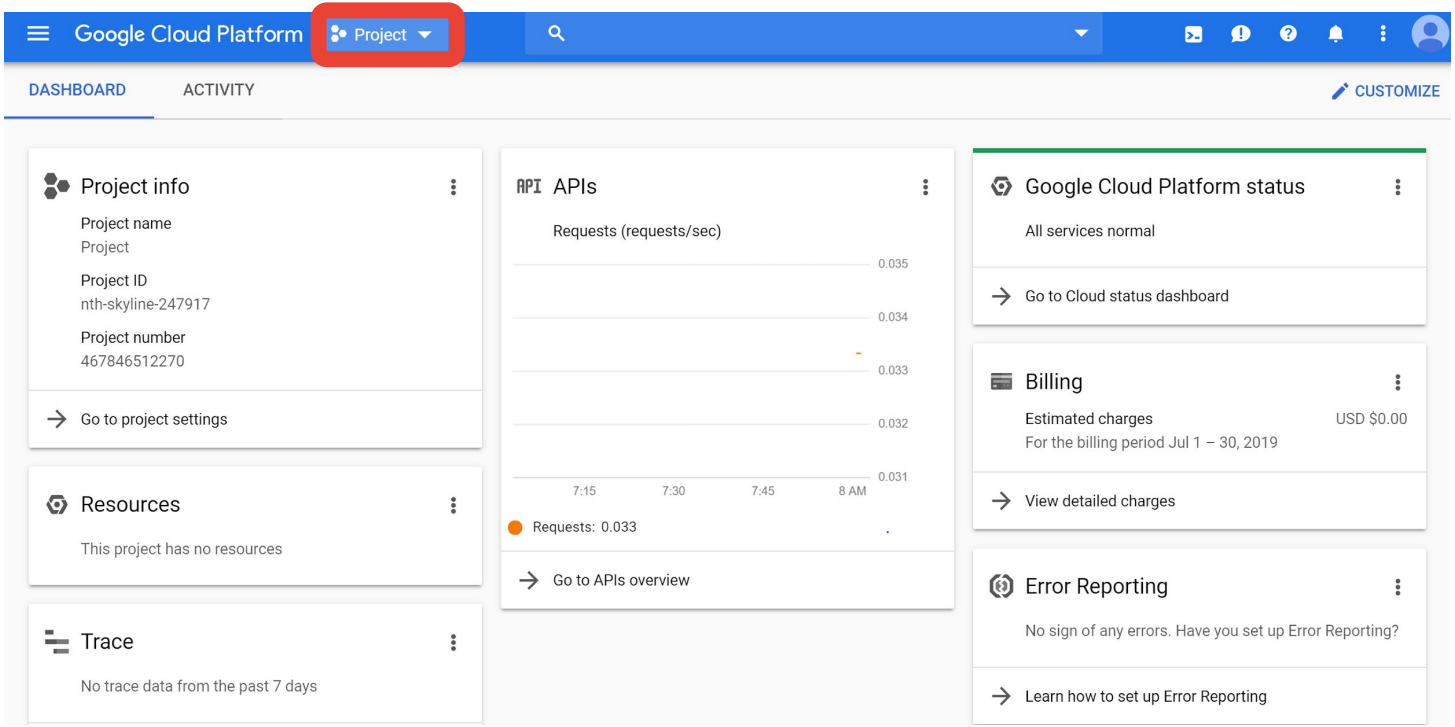


Google Cloud

Projects have three identifying attributes

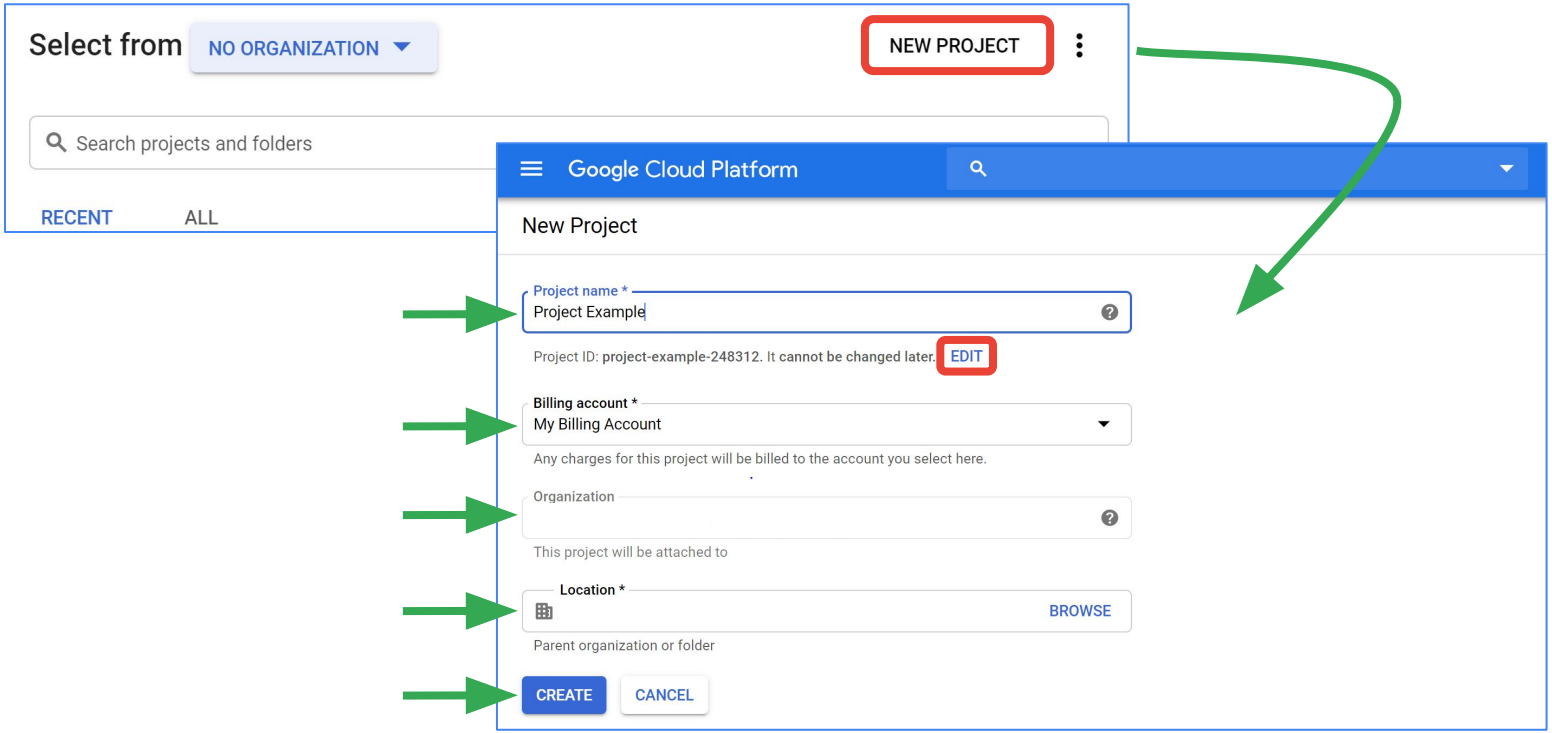
Project ID	Project name	Project number
Globally unique	Need not be unique	Globally unique
Assigned by Google Cloud but mutable during creation	Chosen by you	Assigned by Google Cloud
Immutable after creation	Mutable	Immutable

Creating a project



Google Cloud

Creating a project

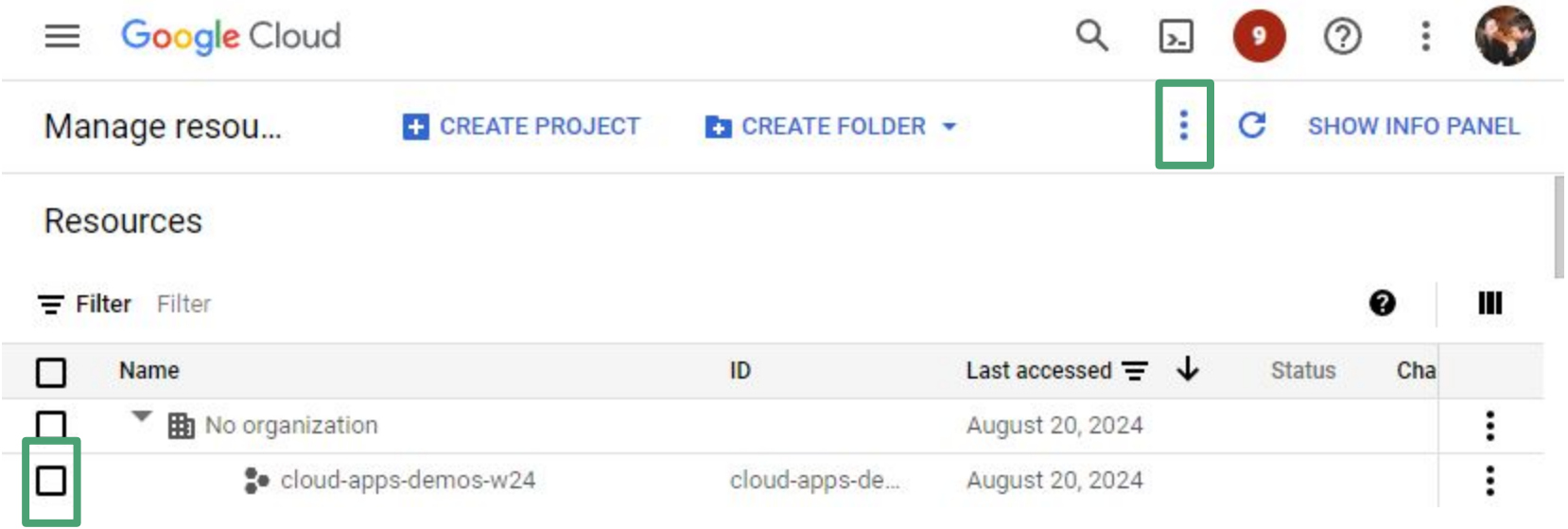


Google Cloud

Deleting a project

Often you may be spinning up a project for class with the intention of deleting it when you're done

- For example, codelabs that require App Engine...


Google Cloud
9
Manage resou...
CREATE PROJECT
CREATE FOLDER
SHOW INFO PANEL
Resources
Filter
Filter
Name
ID
Last accessed
Status
Cha
No organization
August 20, 2024
cloud-apps-demos-w24
cloud-apps-de...
August 20, 2024

One other thing

At some point, you may receive a message that you have **too many projects and can't create another**

- At this point, **you** need to put in a request with Google to increase your capacity
- (I don't have control over your account!)

Another point re billing/projects

Each project is tied to a billing account

Meaning, if billing account has $0, then project is inactive

- Can't be used
- Or edited
- Or any source code downloaded for storage
    - So back up anything critical often!
    - Examples of critical things to backup?

Eventually, projects with no billing account are deleted and **not recoverable**

Demo: Spinning up a (free) VM

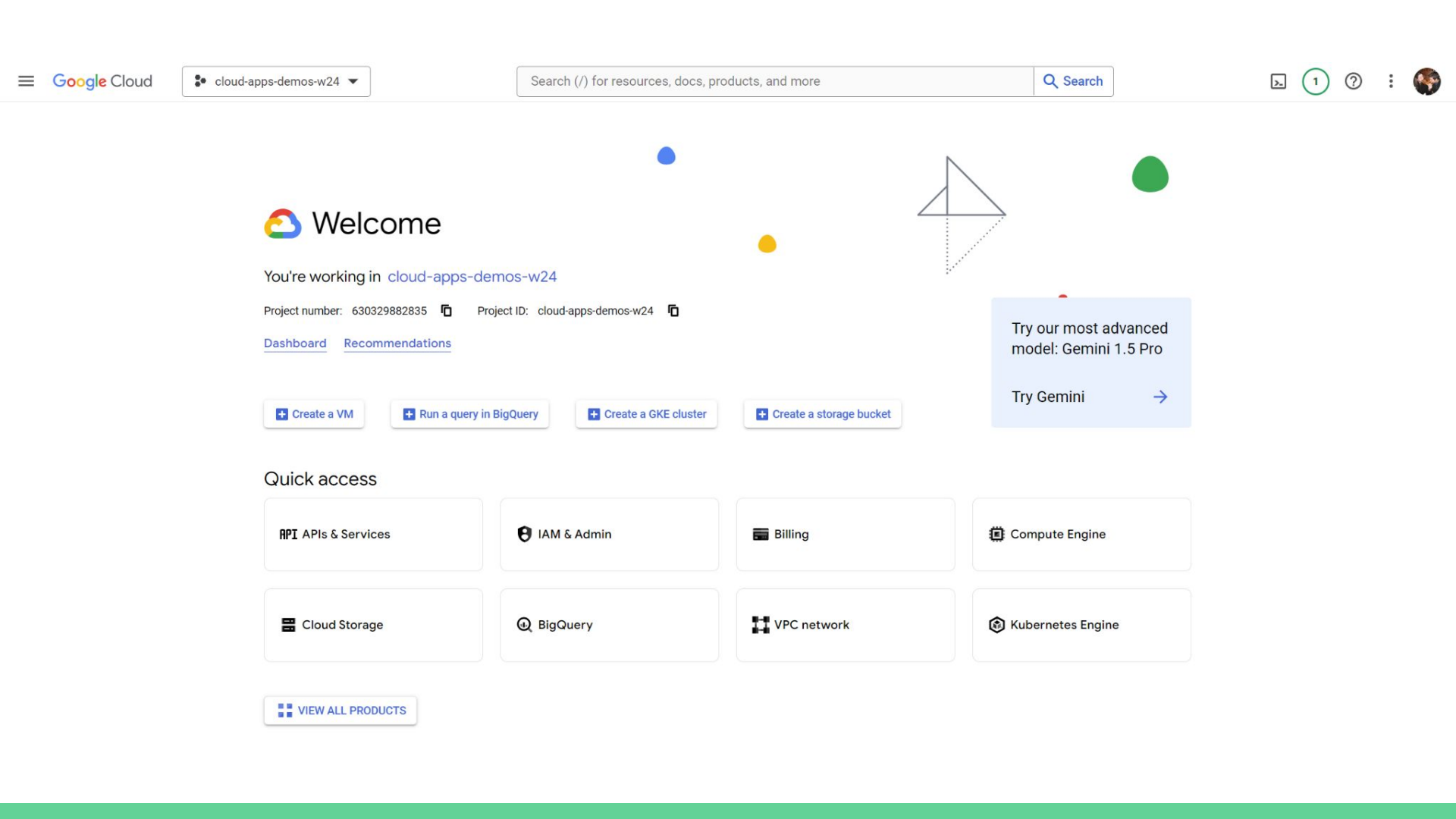
Your first assignment will have you setup your cloud accounts and create a web server, let's look at the VM+web server part of it

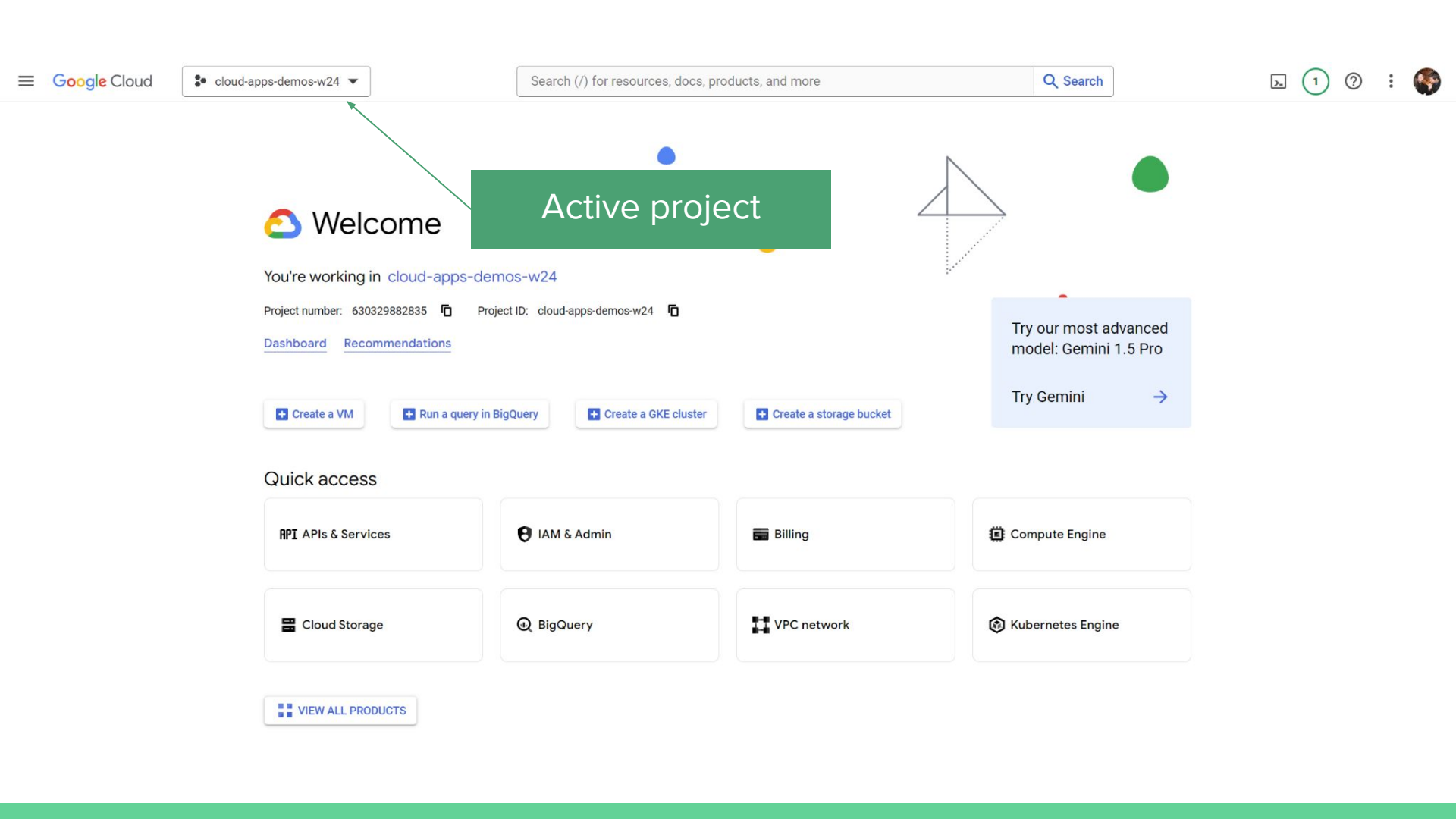
Assignment is in Blackboard!

Demo: Spinning up a (free) VM

First, a look at the free tiers: https://cloud.google.com/free

Compute Engine	• 1 non-preemptible `e2-micro` VM instance per month in one of the following US regions:
	  • Oregon: `us-west1`
	  • Iowa: `us-central1`
	  • South Carolina: `us-east1`
	• 30 GB-months standard persistent disk
	• 1 GB of outbound data transfer from North America to all region destinations (excluding China and Australia) per month
	
	Your Free Tier `e2-micro` instance limit is by time, not by instance. Each month, eligible use of all of your `e2-micro` instances is free until you have used a number of hours equal to the total hours in the current month. Usage calculations are combined across the supported regions.
	
	Compute Engine free tier does not charge for an external IP address.
	
	GPUs and TPUs are not included in the Free Tier offer. You are always charged for GPUs and TPUs that you add to VM instances.
	
	Learn more


Google Cloud
cloud-apps-demos-w24
Search (/) for resources, docs, products, and more
Search
1
Welcome
You're working in cloud-apps-demos-w24
Project number: 630329882835
Project ID: cloud-apps-demos-w24
Dashboard
Recommendations
Try our most advanced model: Gemini 1.5 Pro
Try Gemini
Create a VM
Run a query in BigQuery
Create a GKE cluster
Create a storage bucket
Quick access
APIs & Services
IAM & Admin
Billing
Compute Engine
Cloud Storage
BigQuery
VPC network
Kubernetes Engine
VIEW ALL PRODUCTS


Google Cloud
cloud-apps-demos-w24
Search (/) for resources, docs, products, and more
Search
Active project
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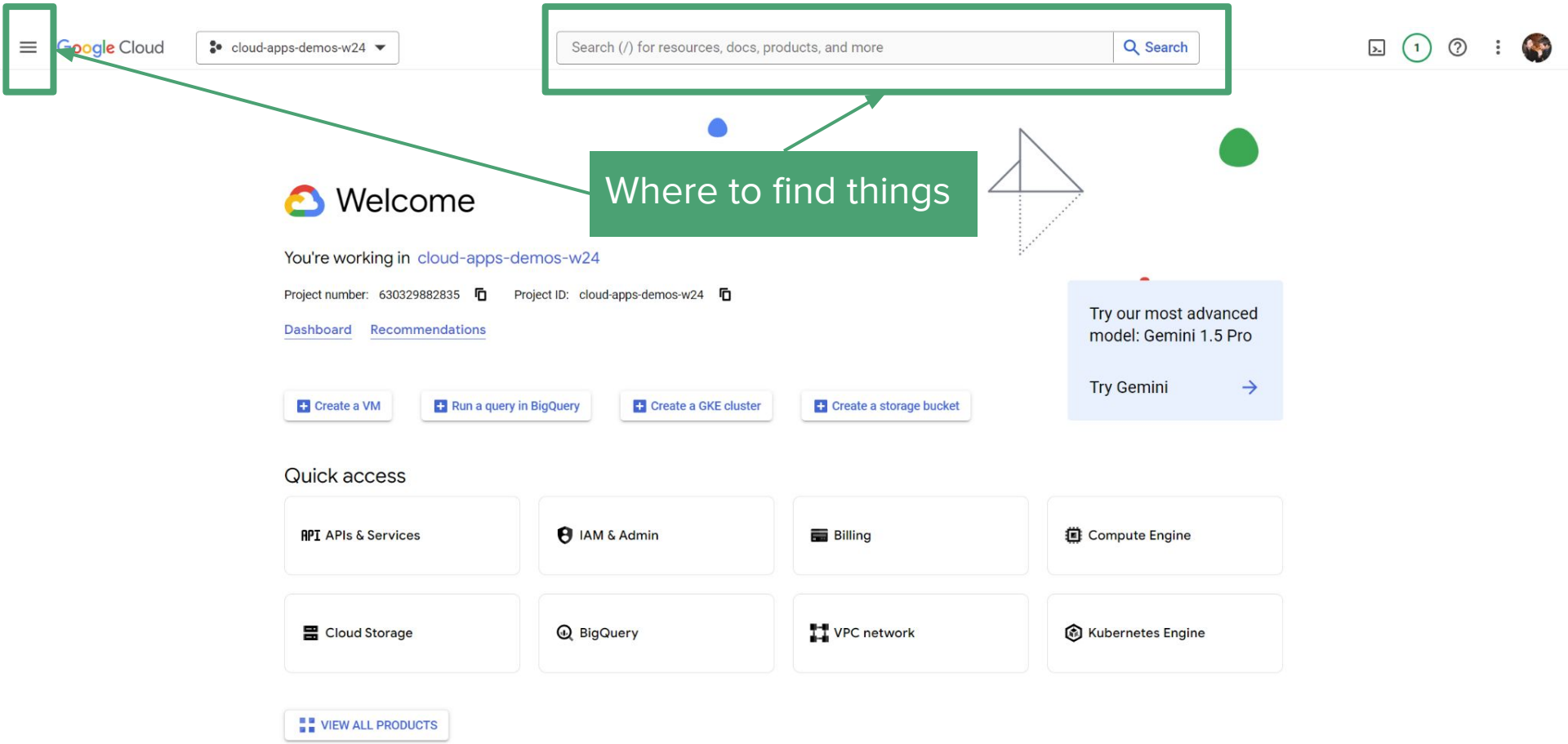
Google Cloud
cloud-apps-demos-w24
Search (/) for resources, docs, products, and more
Search
Where to find things
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Cloud Storage
BigQuery
VPC network
Kubernetes Engine
VIEW ALL PRODUCTS

Create an instance

EQUIVALENT CODE

- **New VM instance** — Create a single VM instance from scratch
- **New VM instance from template** — Create a single VM instance from an existing template
- **New VM instance from machine image** — Create a single VM instance from an existing machine image
- **Marketplace** — Deploy a ready-to-go solution onto a VM instance

Name *: instance-20240528-212102

MANAGE TAGS AND LABELS

Region *: us-central1 (Iowa) — Region is permanent

Zone *: us-central1-a — Zone is permanent

Machine configuration

General purpose | Compute optimized | Memory optimized | Storage optimized NEW | GPUs

Machine types for common workloads, optimized for cost and flexibility

	Series	Description	vCPUs	Memory	Platform
○	N4	Flexible & cost-optimized	2 - 80	4 - 640 GB	Intel Emerald Rapids
○	C3	Consistently high performance	4 - 176	8 - 1,408 GB	Intel Sapphire Rapids
○	C3D	Consistently high performance	4 - 360	8 - 2,880 GB	AMD Genoa
◉	E2	Low cost, day-to-day computing	0.25 - 32	1 - 128 GB	Based on availability
○	N2	Balanced price & performance	2 - 128	2 - 864 GB	Intel Cascade and Ice Lake
○	N2D	Balanced price & performance	2 - 224	2 - 896 GB	AMD EPYC
○	T2A	Scale-out workloads	1 - 48	4 - 192 GB	Ampere Altra Arm
○	T2D	Scale-out workloads	1 - 60	4 - 240 GB	AMD EPYC Milan
○	N1	Balanced price & performance	0.25 - 96	0.6 - 624 GB	Intel Skylake

Machine type

Choose a machine type with preset amounts of vCPUs and memory that suit most workloads.
Or, you can create a custom machine for your workload's particular needs. Learn more

PRESET | CUSTOM

e2-medium (2 vCPU, 1 core, 4 GB memory)

Monthly estimate

$25.46

That's about $0.03 hourly

Pay for what you use: no upfront costs and per second billing

Item	Monthly estimate
2 vCPU + 4 GB memory	$24.46
10 GB balanced persistent disk	$1.00
Total	$25.46

Compute Engine pricing

LESS

CREATE | CANCEL | EQUIVALENT CODE

Fill out with free tier reqs!

Then, install a LAMP stack

Typically the servers will be running Linux

- Much cheaper than Windows Server
- Get comfortable with Linux commands if you aren't!
    - https://www.geeksforgeeks.org/linux-commands-cheat-sheet/

(I'll be running them with Ubuntu mainly, but any install is valid as long as you know how to use it)

- AND SECURE IT
    - ....why?

Ok, LAMP

L : Linux
A : Apache
M : MySQL
P : PHP

https://www.digitalocean.com/community/tutorials/how-to-install-lamp-stack-on-ubuntu

And then, open ports in the firewall**s**

More than 1 firewall?

Inner firewall ➜ your virtual machine
- YOUR RESPONSIBILITY TO MANAGE

Outer firewall ➜ VPC network
- Provider's responsibility (though you specify ports)

MAKE SURE YOU OPEN UP SSH AS WELL (on the VM only)
- If you don't, you will lose the ability to remote into your machine
- Recovery instructions: https://www.youtube.com/watch?v=8cKnIkYYsDQ

What's the difference?

Internal IP	External IP
10.142.0.2 (nic0)	35.231.243.61 (nic0)

Make a website?

Going to cheat, let's just clone a Minesweeper game I worked on over the summer

- For fun!
- Hooray!

```
$ cd /var/www/html
$ git clone https://github.com/efredericks/p5-minesweeper
```

Now...

Visit the **external IP address**

- Should access the `/var/www/html` folder by default (default Apache page)
- sub-folder for cloned site

Easy peasy "free" website

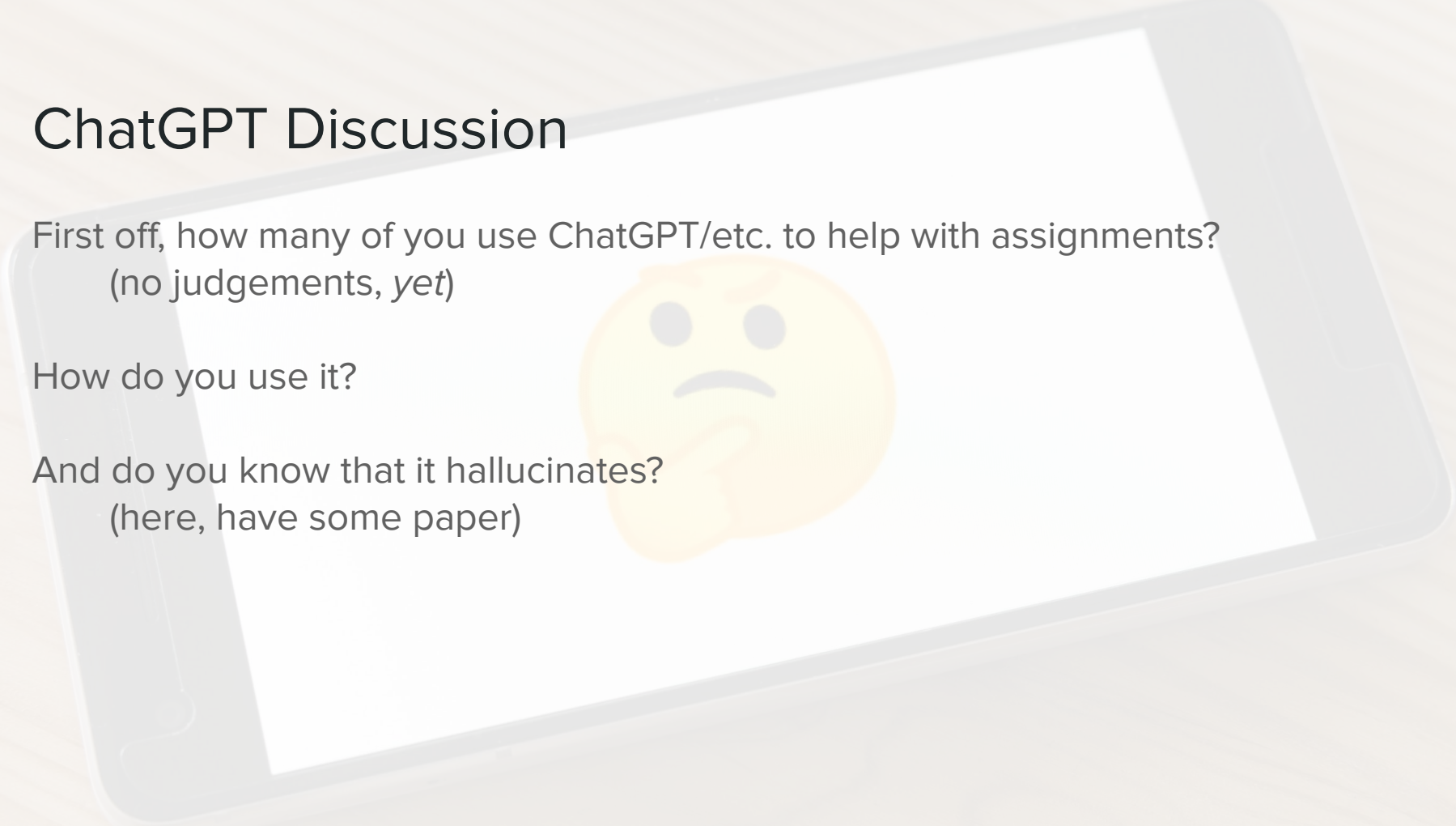
Didn't use the M or P aspects of LAMP - but they are there for your storage/server-side scripting needs

ChatGPT Discussion

First off, how many of you use ChatGPT/etc. to help with assignments?
(no judgements, *yet*)

How do you use it?

And do you know that it hallucinates?
(here, have some paper)



ChatGPT Discussion

So should we use it or not use it?

Well, the genie's out of the bottle and it is probably here to stay (unless if that lawsuit is successful...)

- Just be aware that its output *may* not be completely correct

...and don't copy and paste it directly into your answers either ಠ_ಠ

HOMEWORK

Homework posted -- accounts setup and web server setup

And now...

In-Class Assignment

What is:

- **One advantage** and **one disadvantage** of cloud computing (in general)
- What is **one use case** for cloud computing?

(Turn in to Blackboard and make sure you include everybody's name on it who participated)